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Proceedings of the Maritimes Regional Advisory Process of the Eastern Scotian Shelf Snow Crab

26-27 February 2003
Mic Mac Amateur Aquatic Club
Dartmouth, Nova Scotia

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Compte rendu du Processus consultatif régional des Maritimes concernant le crabe des neiges de l'est du plateau néo-écossais

du 26 au 27 février 2003
Mic Mac Amateur Aquatic Club
Dartmouth (Nouvelle-Écosse)

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March 2003 / Mars 2003

Canada

FOREWORD

The purpose of these proceedings is to archive the activities and discussions of the meeting, including research recommendations, uncertainties, and to provide a place to formally archive official minority opinions. As such, interpretations and opinions presented in this report may be factually incorrect or mis-leading, but are included to record as faithfully as possible what transpired at the meeting. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement had been reached.

AVANT-PROPOS

Le présent compte rendu fait état des activités et des discussions qui ont eu lieu à la réunion, notamment en ce qui concerne les recommandations de recherche et les incertitudes; il sert aussi à consigner en bonne et due forme les opinions minoritaires officielles. Les interprétations et opinions qui y sont présentées peuvent être incorrectes sur le plan des faits ou trompeuses, mais elles sont intégrées au document pour que celui-ci reflète le plus fidèlement possible ce qui s'est dit à la réunion. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s'il est clairement indiqué qu'elle l'est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire.

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ABSTRACT

These proceedings record discussions that were held during the Regional Advisory Process (RAP) meetings for Scotian Shelf Snow Crab stocks in Maritimes Region on February 26-27, 2003. The scientific peer review of Eastern Nova Scotia Snow Crab and Southwestern Nova Scotia Snow crab was conducted. The discussions from this meeting are presented in this document.

RÉSUMÉ

Le présent compte rendu relate les discussions tenues pendant les réunions du Processus consultatif régional (PCR) portant sur les stocks de crabe des neiges du plateau néo-écossais, dans la Région des Maritimes, les 26 et 27 février 2003. Lors de ces réunions, on a procédé à un examen scientifique par les pairs de l'état des stocks de crabe des neiges de l'est de la Nouvelle-Écosse et du sud-ouest de la Nouvelle-Écosse; les discussions auxquelles il a donné lieu sont présentées ici.

INTRODUCTION

The meeting were held the Mic Mac Amateur Aquatic Club, Dartmouth, 26-27 February 2003. The Invitation letter and list of Invitees are in Appendix 1 and 2. The Chairman, René Lavoie, welcomed the participants (Appendix 3), explained the procedure for the meeting, the specific role of scientific referees, industry representatives and observers, and reviewed the agenda (Appendix 4).

The Chairman explained that the objective of the meeting was to conduct a thorough peer review of the stock assessments presented by biologist-in-charge Michel Biron with input from representatives of the province of Nova Scotia and from the industry. He also clarified that the RAP was NOT the place to discuss management considerations. The Remit for this meeting is in Appendix 5.

In these proceedings, summaries of presentations and comments from referees are the work of the authors and have been reproduced with little or no editing.

SUMMARY OF PRESENTATIONS

Summary of Scotian Shelf Snow Crab RAP Presentation on Environmental Conditions

K.F. Drinkwater

Environmental factors, such as water temperature, can affect the molting and reproductive dynamics, as well as the movement, of crab. Bottom (60-200 m) temperatures over most of the northeastern Scotian Shelf and Sydney Bight are generally less than 4°C, which are considered good thermal conditions for snow crab. Information on the sea temperature conditions during 2002 in the snow crab fishing areas 20-24 was presented and compared to 2001 and the long-term means. Data were available from the annual snow crab (February to November) and groundfish (July) surveys on the Scotian Shelf, and additional data were collected as part of regular monitoring programs, from fisherman, scientific studies and opportunistic sampling. Bottom temperatures tended to vary between warmer and colder-than-average throughout the northeastern Scotian Shelf with a slight predominance of former. The snow crab habitat index, defined by the area of the bottom of the northeastern Scotian Shelf and Sydney Bight covered by waters between -1° to 3°C, remained high from the late-1980s to the late 1990s as cold conditions dominated. In 2002, these habitat indices were near to their long-term means and declined from 2001 levels. The temperatures within this area of -1° to 3°C were also near normal but increased compared to 2001. Bottom temperatures within the snow crab fishing areas of the northeastern Scotian Shelf were near to slightly above average in 2002, and increased over the colder-than-normal temperatures that dominated during 2001. The vertical temperature profiles within each of the snow crab areas indicated a tendency for near normal values below 100 m, except in Area 24 where temperatures were below the long-term average. The crabs caught during the annual snow crab

surveys in all areas were generally in warmer waters in 2002 than in 2001, which is believed to reflect the availability of warmer temperatures. However, consistent with past years, the average temperature where the crabs were caught tended to be slightly colder than the average temperature available to them in the northeastern Shelf and on Sydney Bight.

Information was also presented on temperatures from Roseway and LaHave Basins in the southwestern Scotian Shelf where a smaller snow crab fishery exists. There, temperatures tend to range from 3°-10°C, much warmer than in the northeast and are considered marginal for snow crab habitation. In LaHave Basin, the bottom temperatures tended to be below the long-term average for the area by upwards of 1°C. In Roseway Basin, at depths of 150 m or so 2002 temperatures were near normal but were above average by 1°-2°C at shallower bottom depths.

Fecundity and Sex Ratio Study

E. Wade

Since 1989, a trawl survey has been conducted in the southern Gulf of St. Lawrence to provide a direct assessment of the snow crab population. The abundance, distribution and size composition of females (preprimiparous, primiparous and multiparous) and adult males 95 mm of carapace width (CW) has been estimated using data from the trawl survey to allow an assessment of the reproductive potential of the stock. Preliminary results showed that the sex ratio between adult males 95 mm CW and mature females, especially in the case of primiparous females, is not synchronized. During the last decade, high abundance of mature females was observed during low abundance of adult males 95 mm and vice-versa. During this period, about 95 % of mature females carried fertilize eggs and highest population fecundity was observed during two periods from 1990 to 1992 and from 1997-2001. The high abundance of mature females observed during 1990 and 1992 produced a peak of new recruits of instars V to VII (2-3 years old after settlement) that we observed during the 1994 and 1995 trawl surveys. The scarcity of these new recruits observed during the 1998 to 2001 trawl surveys may be due to the low abundance of mature females during the 1993 to 1996 periods. A new wave of recruits, instars V and VII, may be observed in 2 or 3 years in our trawl survey based on the high abundance of mature females since 1997. However, a decrease in the abundance of mature females is anticipated starting in 2002 based on the sharp decline in preprimiparous females in the population.

Based on these analyses, we further discussed the feasibility of sex ratio based stock management in the southern Gulf of St. Lawrence snow crab fishery and its limitation.

Discussion

Dave Orr
Q: How do you treat recruitment in your mortality estimation?

A: There was no recruitment due to growth. Fishery recruitment was an integral part of the model.

Paul Kehoe
Q: 3 females for 1 male in the Gulf, but what about in the ENS? What would happen if it was inverse?
A: We have no study done for this and no information.

Q: Why weren't sex ratio analyses done for ENS? Is it a catch ability problem?
A: (Mikio Moriyasu) We don't have a problem to catch females, but we know there is a drop in the female concentration. Very few females were found and the sex ratio is very skewed towards males. We also don't have the biological background information from ENS; count of eggs, number of females, etc. We also think the mating might be irrelevant because we don't know if there is a self-reproduction in the region. We know that a big part of the stock comes from larval movement form the Gulf. It is questionable whether we could manage the population with any impact using the sex-ratio as an index of population sustainability.

Q: If the female population is dropping, should this be an alarm??
A: (Mikio Moriyasu) This is a time of dying out period of females like in 1995. Probably in 2 years there should be a regain, but we cannot tell and it is too soon to sound the alarm for now.

Herb Nash
Q: Are crabs spawning as a group? So if there is a small stock, do females spawn more and if the stock is low, do females spawn less?
A: (Mikio Moriyasu) We don't know, but female abundance change every 10 years. 4-5 years its high and then 4-5 years its low, so it's a cyclic. We think this is what's happening in the snow crab fishery.

Bruce Osborne
Q: What are the factors of female decline? How is the fishing of the males implicated in the decline of the females?
A: One of the thing that is showed out is the sex ratio and a high sex ration will decrease the fecundity level.

Q: I'm sceptical of the strength of your results (meaning the inference that fluctuations of the sex ratio affect future recruitment six or seven years down the line). Are there other possible influences to explain female population dynamics?
A: More empirical results will be needed to support the proposed hypothesis regarding the role of sex-ratios on the population dynamics.

Michel Comeau
Q: Where so the primiparous females fit in your theory?
A: (Miko Moriyasu) We think that the primiparous female can reproduce with the smaller males.

Q: Does the female have a yearly cycle or a biyearly cycle?
A: (Miko Moriyasu) Primiparous females follow 2 year cycles. I have an interesting theory I'm working on right now, but I'm not telling you.

Q: Do all the stocks adjust to area 12? Is there a correlation between over fishing in the southern Gulf in the 1980s and the stock in adjacent zones (due to the reduction of fecundity)?
A: There is evidence by Bernard St-Marie, and when the sex ratio was biased, there was robust evidence that females reproduce less, do to a lack of prime males. We are not sure if the lack of fecundity is due to over fishing, there might be something else in there.
Sex-ratio should not be thought of an important management tool during the entire fishing period. Sex-ratio changes naturally with time. We do not know with what degree of confidence we may use it as a management tool. Genetic studies showed that the stock is homogeneous throughout the southern Gulf, which implies a fair degree of mixing. We are not convinced we can manage the ENS stock by sex-ratio based management.

Description of an Epibiont

L. Savoie

Epibiosis is a common colonization mechanism used by benthic sessile marine organism that we call epibiont. An epibiont can be a plant (epiphytes) or a sessile animal (epizoans) that grows attached to a living surface in this case the snow crab *Chionoecetes opilio*. Those epibiont communities will benefits from this association. In densely populated marine environments where competition for space is high the advantage of colonizing an as yet unoccupied surface is probably the dominant reason for the fouling of the snow crab. The snow crab will prevent a newly emerging surface created by the crab growth, a hydrodynamically favorable position for nutritional conditions and facilitate dispersal and gene flow among epibiont populations.

Objectives of the Study

During the past years, different epibiont communities on snow crab shell have been observed between the gulf of St. Lawrence and carapace stages. This classification developed for the southern gulf of St. Lawrence based on the Scotian Shelf. Those epibiont communities play an important role for the classification of carapace condition, durometer reading and corresponding approximate age after terminal molt is being used on the Scotian shelf. If we are observing different epibiont communities between the 2 regions, can this classification can be used for the Scotian shelf? To answer this question, I will compare relative abundance and document the frequency of epibiotic organism between those 2 regions, at different depths and seasons. After looking at that, I make sure that the classification used in the gulf of St. Lawrence can properly be used for the Scotian Shelf.

Materials and Methods

Sample Collection:

Snow crab are collected by trawling with a Bigouden *Nephrops* trawl during the annual trawl survey conducted in the gulf of St. Lawrence and on the Scotian Shelf by D.F.O. Each region has 5 study sites where 30 male snow crabs are collected from each site. The sites in the gulf of St. Lawrence have been sampled in 2001 and 2002 and will be sample in 2003. The sites on the Scotian Shelf have been sampled in 2002 and will be sample in 2003. To verify between depths and seasons, around 180 male snow crabs were collected at 4 different times (September 2001 and May, July, and October 2002) and at different depths around eastern Cape Breton. All the crabs was frozen and brought back to laboratory for analysis.

Epibionts Observed (for the year 2001):

Depending on the region different epibiont communities was observed. The occurrence of barnacle was dominant around Cape Breton and in the gulf of St. Lawrence the occurrence of *Spirorbis* sp. (tubeworms) and bryozoans was dominant. The percentage frequency of different epibionts by carapace condition is more variable in the gulf of St. Lawrence compare to eastern Cape Breton where's the percentage of frequency is similar between different carapace condition. The percentage frequency of epibiont communities doesn't seem to varie between depth. The same species are found at each range of depth.

Discussion

Ken Drinkwater
Q: Is there enough differences between Gulf and ENS on barnacles or are they all the same? Could you use those as a mean of transportation and is that part of the study?
A: No, it's not part of the study. I don't look for a movement from the barnacles. The goal of the research was primarily to describe the epibiont distribution in the various regions and not to use their differential spatial distributions to infer movement.

Snow Crab Tagging Program
C. Sabean

The snow crab section at DFO, Moncton has been conducting tagging experiments since 1993 throughout the southern Gulf of St. Lawrence and Eastern Nova Scotia. Currently, modified spaghetti tags are used to tag young adult male crabs. Attached to each tag are a small plastic disk and a metal sleeve. Each disk has an address and unique number, which is used to identify the tagged crab. Young adult male snow crab are distinguished from adolescent males by their large, round chela.

Once the crab is selected, measurements of the carapace width and chela height are taken using a modified vernier caliper. The widest parts of the carapace and right chela are measured including spines. The tag is placed around the crab between the second and third legs and is tightened. With the tag in this position, the male crab can still open his abdomen, which is necessary for mating. Pliers are used to squeeze the metal sleeve, which secures the tag. The excess tubing is then clipped off.

The number of recaptured crab depends on several variables. Obviously, the more crab that are tagged the greater the chance of recapture. The location and timing of release is important. There will be an increased number of recaptures if the crab are released within or near the usual fishing grounds. Many crabs tagged before or during the fishery will be recaptured during that fishing season. Those crab tagged after the completion of the fishing season will not chance to be recaptured until the following fishing season, giving them time to move around. The exploitation rate and level of fishing effort in a given area will influence the numbers of crabs that are recaptured. The age of crab tagged will also affect the return rate. Very old crab may only live one or two years, reducing the amount of time they have to be recaptured, while a young adult may live for another four to seven years. There is mortality associated with tagging crabs. On particularly cold or hot days, there may be an increase in the mortality rate after release because of the sensitivity of snow crab to temperatures outside the 0-5°C range. The experience of the person tagging the crab can also affect recapture rates. If tags are placed around the crab too tightly, the crab may die and if adolescent crab are tagged, they may die during the moulting process. The snow crab fishery in Atlantic Canada selects for commercial sized males. This means that there is a reduction in the possibility of catching tagged crab that are not of legal size.

The analysis of tagging data is limited by the inability to calculated tag loss rates. Tags may fall off because they were not properly secured. In the case of accidentally tagged adolescent crab, the crab may die during while moulting. Natural mortality of the tagged snow crab may also occur. The number of recaptured tags that are not reported by fishermen because they are misplaced or forgotten is also impossible to calculate. Another limitation is the capacity to calculate the amount of dispersion that occurs before the released crab reaches the bottom of the ocean. As well, the coordinates submitted are not verified with each fisherman. Therefore, analysis is based on multiple returns in a particular area over a number of years.

Discussion

Peter Koeller
Q: What is the objective relative to the management regime and what are you hoping to find?
A: (Michel Biron) One of the objectives was to show that all the areas were the same. Also it was to provide an indirect measurement of soft crab. Then we started to go in the Eastern Nova Scotia areas and concluded that the result coming out of tagging

was the extent of movement. It is unpredictable and the crabs do not follow the area borders. They move from one area to another and the objective is to see if there is a direction or pattern of movement.

Ken Drinkwater
Q: In terms of movement on the ENS Shelf, can you give us an indication on the movement and what was the max movement?
A: There are recaptures as far as area 20 from area 24, Chedabucto Bay. We also saw some from area 22 to areas 19 and 18. The maximum distance observed for an individual crab was 158 km.

Neil P. MacMullin
Q: Is there any tagging in the Glace Bay hole? Is there an explanation for the low recapture rate?
A: (Michel Biron) There is more movement from the Glace Bay hole to other areas. 95% were recaptured outside the hole. It could be the movement or the people who don't report their tags. More tagging research is needed before we are able to draw conclusions from the Glace Bay Hole region.

Q: (Michel Biron) Any tagging projects in the near future in the Glace Bay hole?
A: No, not for now, but if we have time, we will!

Bob Anderson
Q: Has there been any attempt to link or model the relationship between the temperature fluctuations and the movement?
A: There is most certainly a link but no analyses have been performed to link the two as yet.

Modeling the Drift, Growth and Survival of the Early Life Stages of Snow Crab in the Gulf of St. Lawrence and Northeast Scotian Shelf

J. Chassé

Physical properties of the ocean, through their influence on growth, mortality and drift of larvae, are important parameters that could influence recruitment of invertebrate stocks. Environmental changes may then have potential effects on the stocks of snow crab in Eastern Canada. Using a model-based approach, the relative effects of circulation, temperature, growth and mortality on the populations of larval snow crab are being studied in the Gulf of St. Lawrence and northeastern Scotian Shelf. The model helps to understand the interaction between the Gulf of St. Lawrence and northeastern Scotian shelf in terms of larvae drift and recruitment in to fishing areas.

A bio-physical semi-lagrangian model is being developed to study these processes. The initial developments focus on improving the biological-physical coupling by developing Individual-Based Models (IBM) of growth and mortality of larvae in relation to environmental conditions. These are incorporated into a full 3-D hydrodynamic model of the ocean. The physical component is a high-resolution

prognostic model capable of long term advection-diffusion of the temperature and salinity fields. The model is been applied to the Gulf of St. Lawrence and North-East Scotian Shelf. It is forced by tides, winds, heat fluxes and inflows at open boundaries. All of the data required to force the model from 1950 to 2003 has been collected. The main biological input to the model is the parameterization of the distribution and abundance of the snow crab mature female in the Southern Gulf as well as growth and mortality rates.

Results of the simulations (1991-2002), show large scale drifts and exportation of snow crab larvae from the southern Gulf of St. Lawrence to the Scotian shelf before settlement at the bottom. This exportation from the Gulf is correlated with variations of the wind field. A sensitivity study to temperature shows that the survival of larvae is highly non-linear, i.e. increasing rapidly with temperature. However, the exportation is sensitive to the vertical distribution of the larvae and more fieldwork is necessary to better understand this important parameter. Indices of exportation and retention are being developed. Connectivity of the sub-stocks, in terms of larval drift, is being investigated.

Discussion

René Lavoie
Q: Is there any similar work being done for the Scotian Shelf?
A: Not now because we don't have the female concentrations on the shelf. No one is doing work on this issue at this moment, but we could look at it in the future.

4X: COMMENTS FROM SCIENTIFIC REFEREES

Comments on Biron, Sabean, Savoie & Moriyasu. Assessment of the 2001/2002 snow crab fishery off southwestern Nova Scotia (NAFO Division 4X)

Michel Comeau

In general, there was very little crabs captured during the trawl survey in area 4X resulting in very large confident intervals. Nevertheless, information based on the exploratory trap survey show that the distribution over the entire 4X area is restricted to two small locations. Also, temperature, that in general plays an important role in the snow crab distribution, is even more important in 4X as this area is at the most southern limit of the snow crab distribution that can sustain a fishery. This latter information hinders the possibility to efficiently manage and achieve a sustainable fishery in this area (4X) due to uncontrollable temperature fluctuations. Although the authors mentioned that the fishery data are not considered reliable, they however show that the fishery in area 4X is highly variable. The authors have to clearly state their management recommendations on page 10 based on their trawl survey, the trap survey carried out by the exploratory licenses, the fishery and oceanological data. They should answer the question, could this fishery reach sustainability based on an

adequate (or any) management plan? Based on the information found in this paper it would be difficult to achieve a sustainable fishery.

John Tremblay
The analysis supports the recommendation of no new effort. In fact consideration should be given to a reduction in quota given
the doubling in licenses since 2000,
the low catch rate (4.9 males per tow) compared to the trawl survey off ENS (7296 males in 300? Tows = 24.3 males per tow)
few signs of recruitment
the TAC of 520 t was not captured

Abstract gives a biomass estimate but the text indicates there is no confidence in this result e.g. from Management Recommendations "fishery parameters estimated from this survey are not considered reliable at present time". Be consistent.

Wasn't there a trap survey last year? Can the catch rates from the trap survey be compared with those from the 2002 trap survey?

I note that the trawl survey caught more females than males (119 females to 102 males). This contrasts with the highly biased ratio off ENS (2852 females to 7296 males). Is the larger proportion of females in 4X a result of not sampling the grounds dominated by males? These could be on harder bottom as suggested in the text. Alternatively the high proportion of females may be a sign that there is a population cycle (indicated by sex ratios) that is out of phase with that off ENS.

Peter Koeller
Abstract:
Possible reason for the change in distribution of the fishery could be mentioned here. Also the origin of the 520 tons. Why was at-sea sampling not adequate? Funding constraints? Timing\co-ordination problems? Is there any sampling from previous years?

Methods
Catch rates: Is there any attempt to intercalibrate/separate results from the 2 trap types?

Tagging: no results are presented other than return rate to date – omit this section?

Results
Why was the fishery concentrated in the north in 2002? How was it distributed previously? Was this change because catches from the previous years were too small in the south?

Again, no previous years' results for commercial sampling are shown in the tables or figures

Why are the results for other crabs presented?

At what temperatures are the crabs in 4X distributed relative to the north and how does it compare to the species preferred range? Some analysis might be helpful in supporting the thesis of non-sustainability. If the population is not sustainable should permanent licences have been allocated? – compare to shrimp in Mahone Bay which were denied permanancy on this basis. Are there any females?

The much lower catch rates for the beginning of the 2002-2003 season are worrisome. Any changes in fishing patterns in 02-03?

Figure 8,12. Is there any explanation of then skewed length distributions in the north from both sea sampling and the trap survey? What is the significance of pigmy males? Why are there more of these in the south? How does the growth/maturity of crabs in 4X compare to the eastern shelf? Has the size of male crabs caught changed over the years?

What was the purpose of "biological sampling" and how does it differ from sea-sampling I assume the latter was exclusive to the tagging project. Only pygmy males were caught by the modified (Japanese?) traps. Were they being targeted? Was the trap modified to catch them?

Dave Orr
The assessment was very thorough and results supported the conclusions that the fishery has probably reached its limit under current environmental conditions and further expansion should not be recommended at this time.

There should be a detailed description of how the fishery changed over time. Was there movement from Roseway Basin to north of La Have Basin? Complete an analysis to show whether the fishery is expanding or contracting. This analysis should be used in concert with a standardized CPUE model. There should be a CPUE model for Japanese pots and one for the large traps. The CPUE model and the analysis of contraction/ expansion help to describe the fishery. These indices can then be used as tools with the research data to provide a more complete assessment.

I also have various specific comments:

Page 1 Introduction:

Indicate:

1) the minimum at sea observer coverage: describe the size of fishing pots (Japanese and large traps); in particular, what are the dimensions of the large pots.

Page 5 - Mapping and estimation of abundance by Kriging

- Why does M. Biron *et al.* make use of a weight length relationship to indirectly determine crab weights? Whynot get direct weight measurements? Is this because there may be varying amount of epibionts on the crabs?

Page 7 - Temperature distribution from trap surveys and fishery

M. Biron *et al.* indicate that the coldest temperatures observed during February occurred off Pennant Point (Fig. 15). However, figure 15 does not indicate where Pennant Point's location.

Other species of crabs

It is not clear why other species of crabs are included in this assessment.

Page 9 - Trawl Survey

The authors continually indicate that there are uncertainties associated with the trawl survey, but never fully describes them. A simple set of points would suffice.

The *Nephrops* trawl was developed to dig into the mud and as such is an inefficient sampler on hard rocky surfaces. Therefore, the trap and trawl surveys should be combined into an adaptive survey allowing research sampling/ biomass estimation on all types of fishing grounds.

Grammar, sentence structure and spelling should be checked before the document is finalized.

Page 10 - Research recommendations:

The second recommendation within the documents states that the trawl survey should be repeated in 2003, yet one of the slides during the discussion questions whether is should be continued.

I am recommending that the logbook data be used to create a standardized CPUE model and that there be spatial analysis of the fishery. Both of these indices would greatly help the assessment.

EASTERN NOVA SCOTIA (AREAS 20-24): COMMENTS FROM SCIENTIFIC REFEREES

Comments on Biron, Savoie, Sabean, Wade & Moriyasu. Assessment of the 2002 snow crab fishery off eastern Nova Scotia (Areas 20-24).

Michel Comeau
In general, the authors should be consistent with their wording, presentation of figures, and the abbreviations. For example, CPUE should be identified as catch per unit effort the first time it is mentioned in the text, but CPUE should be used afterward. This is not the case in the paper for most of their abbreviations. Also, sometime in the text CFA 20 is used and sometime CFA-20 is used. The authors should be consistent. There is numerous modifications penciled directly on the manuscript. This is not a data-poor report. The authors have not presented all the data available, and have not successfully point out the more relevant information and make a synthesis of their results to clearly identify the uncertainties and formulate recommendations.

In more detail,
The abstract has to be more informative. As it stands, it is too short and many items presented and discussed in the text are missing.
P. 12. It is mentioned that the survey area could influence the estimation of the total biomass. Explain in the text how the survey area could influence the estimation the total biomass. Based solely on Fig. 32, the abundance of snow crab has decreased from 2001 to 2002. This observation it not clearly stated in the document. However, if it is an artifact due to different survey area between the years, it should be explained to allow the reader to understand. As it stands, the text does not match the figure presented.
There are redundancies in the discussion (pages 13 and 15). Particularly on page 15, the relationship between movement and temperature is repeated numerously in the text.
Page 13 the logbook sub-section. It should be mentioned that CPUE alone is not a reliable parameter to speculate on the status of the biomass. The authors should discuss the relationship between CPUE and changes observed in the fishing activities and information from fishery independent parameters (their trawl survey). For example, a change in the fishing activities such as a longer soak time and/or a concentration of the fishing activities in small areas could artificially sustain or increase CPUE. Although the nominal effort has not increase, the effective effort has. If such an increase in the effective effort has not produced an increase in the CPUE, it could be a sign that the biomass is showing signs of slowing down. The statement at the end of the second paragraph should be removed and replaced by an explication. The authors' conclusion should be clearly stated at the end of that paragraph.

Page 13 the at-sea observers sub-section. As per *comment 4*, CPUE is not relevant if it is not in context of the fishing activities. The paragraphs should be written as a function cf the CPUE and the fishing activities. The last sentence of the second paragraph of this sub-section should be re-written based on the pre-cautionary terminology. It should read "The ENS fisheries are not in a critical (or severe) situation based on the at-sea observations". The pre-cautionary terminology should also be used elsewhere in the text. For instant, if there are evidences that the

biomass will significantly decrease, and it is not a question of if or when, wording such as "the ENS fisheries are heading toward a severe situation" should be mentioned in the text. From the evidences presented in this paper, I think that the ENS fisheries are already in the first stage of a critical situation, and the next management plan should be adjusted accordingly and be less aggressive.

The second paragraph of the biomass and abundance estimates has to be totally re-written. I do not understand its meaning.

The second paragraph on page 17 present a new theory that need to be peer reviewed. We do not have enough data and solid evidences here to judge this new theory. However, this is clearly new hypothesis (speculations) and should be written as such. Are and is in the majority of the sentences have to be replaced by would, could and should. Nevertheless, there are some questions that beg some answers. What is the contribution of the primiparous females? How does this theory influenced by the larval drift?

John Tremblay

Major points – As I indicated last year, this assessment has come a long way in the last number of years. The tagging results included this year are a useful addition.

I realize that the task of putting the assessment together is huge. Nevertheless I am concerned that several of the comments made last year have not been addressed. Since these comments are still very relevant, they are repeated below:

...there is considerable weight given to the commercial CPUE data but no detailed analysis of what might be affecting it (e.g. soak time, trap type?,

Regarding the stock status...are there any other indicators of stock health that might be developed? E.g. female fertilization rate

Regarding the CPUE data, in last year's assessment there was a heavy reliance on commercial CPUE, and some downplaying of the significance of the trawl survey results. There was no analysis of the CPUE data. This year it is the commercial CPUE data that are downplayed but again there is no attempt at analysis of the factors affecting catch rate. What is more confusing is that the at-sea samples apparently support the high catch rates generated from logs but these are said to be less than representative (more on this below).
The CPUE data appear to be increasingly divergent from the trawl survey results. A look at Fig. 25 for example (survey density of different sizes for north-eastern NS from 1997-2002) would indicate that commercial CPUE should have been markedly less than both 2001 and 2000. In fact 2002 CPUE was about 6% higher than 2001 and 47 % higher than 2000. Some possible reasons are given for the high CPUE in 2002, but there is no analysis. Compared to 1998, CPUE is 2 ½ times higher yet the 1998 survey results would suggest abundance was higher in 1998. The authors make the point that the survey accounting has improved steadily. If this is the case it

would be worth while re-estimating the abundance for previous years using the current survey assessment methods.

Regarding indices of stock health (second comment highlighted from last year), there appear to be no data presented on females. The Results comment on female abundance but I cannot find any associated tables or figures e.g. for northern ENS: "In 2002 as in 2001, adult female abundance and distribution was generally low and almost exclusively comprised of multiparous females". Low compared to what? Males? Or previous years? This data must be presented and examined more thoroughly. This is particularly true since the authors make much of the importance of female abundance in a cautionary (but not easily understood) paragraph in the Biomass and abundance estimates section.

Abstract
"margin of error was reduced by eliminating source of underestimation". This statement is not supported.

Introduction
Refer to Tremblay, Eagles & Elner 1994 for early history of the fishery

Materials & Methods
As per last year's request: Provide % of landings represented by "properly completed logs"
This is important to get an idea how representative the properly completed log landings are.

Change Sea Sampling to Sea and Port Sampling

Exploratory trap survey…
Sable Gully is not yet a protected area. Change to candidate protected area.

Annual trawl survey

Projected Habitat Areas (PHA) – give a figure showing the masks for the non-commercial & commercial categories. Show what are they based on.
How has the station coverage changed over time & how has this affected the annual biomass estimates?
Please indicate how the recorded tow information is used. Are the numbers for each tow corrected independently for area swept?

Results
Fishery
CPUE and effort
Needs to be more analysis here of effects of soak time

At the very least some indication of the number of days fished compared to previous years would give an indication of whether more effort was needed in 2002 to catch the quota
Page 9 – Are annual changes in CW of 1-3 mm important? They are mentioned but there is no analysis and unclear criteria for judging whether a change occurred or not. e.g. on p. 9: At-sea sampling by observers: In 2002 the mean CW of at-sea samples were 108.4 mm and 106.8 mm…, a decrease compared to 109.6 mm and 108.7 mm. At the bottom of the page, a CW of 114.1 mm in 2001 is said to be comparable to 112.7 mm in 2002.
Recommendation – provide analysis or remove any comments suggesting increases or decreases in CW
Trawl survey
Present data on females. It is important to know how their abundance has fluctuated annually

Figs. 29 & 30. Combine these 2 figs. that are largely redundant & a little confusing. Just add two different points for the 2 surveys in 2002.

All Figure captions related to the trawl survey : Ensure that survey timing is mentioned (spring or fall) and that males are mentioned.

Discussion
p. 12-13 – Unsure what to make of CPUE. This section definitely needs to be rewritten. Much is made of reasons why the log CPUE is unreliable but here we learn that At-sea Observers reported comparable but generally higher CPUEs than logs. How can at-sea observers record higher CPUEs than logbooks (p. 13, paragraph 3) if double hauling is suspected? One would think if a 1000 kg are caught in 10 traps hauled twice, the logs might indicate a CPUE of 100 kg/trap but the observer would record 50 kg/trap. In the next paragraph (4th on p. 13, it is stated that "Overall CPUEs estimated from observer data validated logbook CPUEs."
If this is the case, and log CPUEs are reliable, please reconcile the decreasing trawl biomass with the increasing commercial CPUEs.

Biomass and abundance estimates
Argument that changing methodology had improved the accounting of snow crab is reasonable. If so, it is necessary to recalculate the biomass for previous years using the current methodology.

p. 17 2nd long paragraph. This needs to be rewritten. I think there is something important regarding females here but I am not sure what it is. It is not clear & terms such as "long-term chained negative cryptic impacts" are not explained and are a good example of bad jargon.

Conclusions & Recommendations
"margin of error was reduced by eliminating source of underestimation". This statement is not supported. Table 20 for example does not indicate a reduction in the

confidence intervals as a % of the mean. I think what the authors are arguing is that the survey is less biased because the survey should be missing fewer crabs outside of the trawl survey area.

Peter Koeller
General comments

The advice is very similar to last year i.e. low recruitment, future decreases expected, maintain (do not increase) the TAC. This advice, if accepted would mean maintaining the record high TACs of about 10, 000 mt in a situation where the productivity of the stock as well as the adult biomass appears to be declining. At the same time the number of permanent licenses has been increased. This does not appear to be consistent with sustainability or precaution.

Despite several new science initiatives, including 2 additional seasonal surveys in the north, tagging and the slope trap survey, there appears to be little new information relevant to determining the status of this stock. In addition few of the concerns in last year's review appear to have been addressed. As noted last year, the practice of reporting only results from the current year, especially for fishery parameters (e.g. weekly landings, catch composition, survey temperatures, crab densities) makes it impossible to determine if there are any temporal trends which may be indicators of a change in stock status. Environmental time series such as temperature would also have been useful in this regard. As also indicated last year, the changes made over the years to the survey are a major concern, and this has only been compounded by the timing change in 2002. If the CPUE data is in doubt because of changes to the distribution of effort, technological changes etc., and the survey is in doubt because of changes to the methodology, then what remains?

The main problem with this assessment appears to be summarized on p. 16 of the document. The second from last paragraph can be paraphrased as follows:

"The trawl survey has shown an alarming decline in recruitment, while the biomass has appeared stable since 1998. However, this perceived stability was incorrect and was due to a series of data manipulations and changes to survey methodology. In fact, the biomass has also been declining."

Apparently these changes were conducted to address various unspecified problems (hopefully not the need for more crabs by industry!). This statement begs a detailed retrospective analysis as to how this misperception could have happened, since it has contributed to the raising of TACs, issuing of new licenses, and possible damage to the productivity of the stock.

The all important issue of the decreasing (absent?) female biomass is mentioned in passing, but no data is provided.

The main advice, presented in the second-from-last paragraph on p. 17 could be re-phrased as follows:

"Due to the uncertainty described above, together with various negative signs including decreases in recruitment, reproductive potential and fishable biomass, it is strongly recommended that the TAC be kept at record levels to ensure sustainability."

Detailed Comments

Abstract:

The abstract is generally misleading. The statement that the fishery data show "generally positive signs in 2002" is a matter of debate. Catch rates increased significantly in 22 &23, but they appear to have increased only slightly or leveled off in 20-21 & 24. No trends are presented for size frequencies for sea sampling or catch composition. The statement that the 2002 biomass is similar to 2001 is an oversimplification and should identify the differences between areas. e.g. Figure 34 shows a decrease in abundance of adult >95 for 2 years in 23 & 24, and no change in the last 3 years in 20-22 after a large decrease. Table 20 shows a 26% decrease in biomass of adult >95 in the south. Table 19 shows a 19% decrease for the spring and a 29% decrease for the fall surveys from 2001 to 2002 (summer survey wasn't done in 2001) Recruitment has been declining for several years not just in 2002 as stated. The statement that the fishable biomass is expected to decline is therefore wrong – in fact it has been declining for several years in 23-24, and it has already declined in 20-22, but is currently holding steady. Consequently it would be more correct to state that the fishable biomass is expected to continue to decline in 23-24 and resume its decline in 20-22. A relatively simple projection model should give us some guidance here as to the magnitude and timing of the decline under certain assumptions. I don't believe that sources of underestimation have been eliminated altogether – that part attributed to timing and migration may have been, but inshore coverage is still limited (?). In addition it could be said that the change in the timing of the survey has introduced a bias in the estimate relative to the previous years! There may be more biomass in the summer 2002 survey than in the spring, but the previous years now need to be calibrated to the summer survey to determine trends, which are probably more important in terms of stock status than an absolutely accurate estimate. Why is there no system if soft shells are being monitored? Presumably action can be taken if deemed necessary. The main problem is that there is no system to determine changes to TACs when biomass changes (except common sense, which can go a long way when applied properly)

Introduction

p.3 2nd para: It is noteworthy that the TAC was nearly tripled in 1 year based on CPUE data. How reliable if CPUE data? For example, the survey has shown decreases in fishable biomass yet the CPUEs have continued to rise? Is there a learning element? Gear and distribution changes e.g. GPS ? To what extent are

CPUEs considered valid estimates of abundance in other snow crab fisheries? Why have a survey?

4th para. The text makes reference to "22 northern" several times but this area is not identified on maps. Do you mean 22 inner?

Materials and Methods

p. 4, 1st para: in calculating effort, state what percentage of the logs were correctly completed.

2nd para: you should state the objective of distributing the fishing effort. Is it achieving this objective based on e.g. movement of crab between areas as deduced from tagging data? Perhaps fishing out one local area while giving another a rest is also an option. Some rationale for taking this approach should be provided.

3rd para: for port sampling, I assume that a *minimum* of 20 crabs are sampled and that 40 are sampled during cloudy days? This is not clear from the description of the methods.

p. 5 2nd para: on what basis were the fishermen selected? Give the type of temperature probes used. What was "the second part of the experiment"? 1991, November?

3rd para: why was the data on the shrimp fishery obtained and why is it presented?

4th para: the word "primordial" seems to be misused in this context

last para: the description of station selection is not clear. Where and why were 1 or 2 stations selected? e.g. area allocation? Are the "same stations" the original selection from the first survey or just from the previous year's surveys? Where and how were the random stations added? i.e. one random and one fixed per area? Was the starting point of each tow when the warp was all out or when the trawl touched down? I expect what you did was start timing 5 minutes from when all the warp was out and then the actual length of the tow was determined after, using the Netminder data. This is not clear in the description.

P6, 1st para: how was snow crab habitat determined? i.e. to determine survey coverage.

3rd para: does CW relationship change with season, maturity stage, shell condition? Is there any information on natural mortality in this species? Is it considered to be higher or lower than, say, other crab species, fish or shrimp? The description of kriging suggests that the new mask was used only beginning in 2001 – presumably the new mask was applied to all survey years.

p.7, 2nd para: the meaning of "no hydrologic value" is misleading, as it suggests that the data shown is not worth showing! If it can't be used for hydrology why can it be used for stock assessment?

Results

Table 1. The TACs or "quotas" for the slope areas are difficult to decipher – the rows appear to be misaligned in this table. What are the annual catches, catch rates along the slope?

4th para: the reason for the blockades should be identified, it might provide some insight into the character of the fishery. What is the difference in the fishing pattern from previous years and how might it have affected catch rates and their interpretation? The previous years' distributions are not given for comparison.

5th para: "...only after permanent fishermen had captured their allocation." Was this a management requirement?

Last para: What is "CFA-22 northern" (outside?).

p. 8, 2nd para: Note that the first 2 headings in the at-sea sampling tables should read "No. of trips" and "No. of traps", otherwise it could be interpreted that e.g. only trap #30 was sampled from trip #9,` i.e. a total of only 5 traps in Table 9. The statement "noticeable differences by comparison to 2001" is not supported by data. The figures for the previous year are referenced in the text but are not placed in any longer term context.

3rd para: How did the transfer of temporary to permanent 1st nation licenses affect the fishing effort and pattern, and how might they affect interpretation of CPUE data?

p.9 2nd para: The description of changes in CPUEs by subarea from the previous year has little meaning unless it is placed in a longer term context. This is a general problem with much of the document.

Is there any indication that technological changes in the fishery since the earlier period of high catches in the 1970s, particularly the availability of GPS, may be influencing our perception of effort and CPUEs between then and now?

4th para: Is there any indication that the slope area may be more vulnerable than the traditional areas e.g. changes in CPUEs within seasons? Any differences between 2002 and 2001 in this regard? Why was the catch so much higher along the slop in 2001 than 2002?

p. 10, tagging: My interpretation from the tagging results is somewhat different than yours i.e. that there is little movement from the Gulf to NENS, but there appears to be considerable alongshore movement in the opposite direction, particularly along the

south shore of Cape Breton. There is also considerable movement in both both directions along the northern shores of Cape Breton, into the Gulf and into Sydney Bite, including cross-sub area migration. Can we draw any preliminary conclusions from these results e.g. as to the value of spreading effort between areas? The statement that recaptures from Bad Neighbour Shoal were randomly distributed doesn't agree with the map, which seems to show alongshore movement. The slope tagging seems to suggest some along slope movement.

p. 11, mobile gear fisheries: probably better titled "mobile shrimp fishery". Note that the updated effort is 7205 hours. Would be worth mentioning that the decrease in effort is due to a decreased TAC. It is not clear why this information is being presented.

p. 11, Annual trawl survey: "....revisited twice in *May and July*...." should read *July and October*. It would be useful to have maps of all the station locations for all years to see how station distribution\allocation may have influenced results over the years.

p.12, temperature distribution: Again, it isn't much use to look at only one year of temperature distributions. Not sure what this is adding to the analysis, if anything. At least try to place this in the context of the species preferred range (is it 1-3C?)

p. 12 Discussion, fisheries and fishery related data: The paragraph on logbooks appears to invalidate the CPUE data, yet it appears to figure heavily in the perception of stock health and setting of TACs (e.g. "logbook data did not suggest any stock decline". Effort appears to be underestimated e.g. unreported double hauling. Any guess as to the magnitude of this problem?

At sea observers: If double hauling was a major problem in the unobserved data, then the CPUE from observers should have been lower not higher, so the statement that the observer data supported misrepresentation of effort does not follow logically. Was it some other kind of misrepresentation that was supported? What does "comparable but higher" mean? Significantly higher? If the observer data did not suggest either over or under-fishing does that mean that fishing was in between i.e. just right?

p. 14, 1st para: move to section on snow crab movement. It is stated that the limit of tolerance is 3-7 degrees. This appears to be a range of upper limits because is stated later that the highest concentrations are found in 1-3 degrees. What is the preferred range?.

p. 15, 1st para.: Are adolescent and adult males <70mm found in shallower water all year? Is there an offshore migration as the inshore warms up as apparently happens with the adults? There did not appear to be any change in the abundance of juveniles or smaller adults in the summer or fall surveys. The results of Figure 26 need to be placed in context of previous work to explain the reason for the increased summer and fall catches of adults.

2nd para, line 7 should read : "fall" should be "summer and fall". It would seem that moving the survey time did not achieve the desired purpose i.e. if crabs are still found inshore during all season. What evidence leads you to think that the area with cold water was less in the fall than the spring? How would this affect snow crab distribution and survey results?

3rd para: How much of a problem are illegal landings?

p. 16, uncertainties: "these concentrations are not limitless": should read "their abundance is unknown"

movement: the statements made here don't make sense.

Biomass and abundance estimates: The second paragraph in this section is quite alarming as described above under general comments.

p. 17, 1st para.: The first part of the paragraph states that the timing of the survey is critical due to seasonal migrations, implying that one has to find a better time to do the survey i.e. change the methodology. The last sentence indicates that the important thing is to do the survey and analysis in a consistent manner. These two statements are contradictory and illustrate continuing confusion of conflicting objectives in this assessment that has to be resolved – determining the best estimate of absolute biomass or producing a useful time series.

2nd para: the "silent critical alert" of low female spawning stock will continue to remain silent if the data is not shown! Why is the disappearance of females termed "quasi". If it is quasi, or not real, presumably it will not result in a stock decline in the future. If it is real, perhaps it is connected to the present decline?

Table 2 & 6: separate statistics into inside and outside as well as total, as in Table 3 & 7.

Table 8 & 14: why not present statistics prior to 1997?

Table 19 & 20 should give biomass estimates for all survey years.

Figure 25: identify the last panel as the spring survey.

Figure 26: The text indicates that there is also a fall 2001 survey (?). If this is the case should it be included in this figure?

Figures 30. This figure is confusing in that it suggests that there has been a spring and a fall survey every year. I suspect Figure uses spring results for earlier years and fall results for the later year(s). Also, is there a problem with the x-axes? i.e. the top panels are 1998-2002 and the bottom are 1997-2001 in both figures 29 and 30.

David Orr

As with the previous document, the assessment was very thorough. A great deal of information was presented. The assessment indicated that the stock was in decline and that we should start thinking about harvest control such that sustainability would be promoted.

Once again there should spatial analysis and CPUE modeling of the fishery. Spatial analysis could simply be completed as follows:

- create a 10' X 10' grid pattern over the fishing area, add up the amount of catch within each grid, order the grids by increasing catch, count the number of grids necessary to account for 95% of the catch, repeat this process for each year throughout the history of the fishery.

This simple index has been used in the past for northern shrimp assessments, cod assessments etc. In general, within Nfld. region, snow crab CPUE was negatively related to the areal index. This made sense because the fishermen tended to concentrate on pockets of snow crab. When the catch rates dropped to 6 kg/pot in 2J, the areal index increased as the fishermen started to search for crab.

The authors can also use indices of percent presence/ absence of various crab maturities within the research traps and trawl survey sets. All of the plots indicating fishing positions (Figs, 3, 8, 12, 23,24 & 37) maps should be replaced by expanding symbol plots.

Specific comments:

Page 2 - Abstract

The second paragraph discusses eliminating sources of underestimation, then in brackets the example is redundant as it merely repeats that sources of underestimation should be eliminated.

Page 4 - Sea sampling

Clearly describe protocols that are set up to avoid bias when randomly sampling 40 snow crabs from randomly sampled pots. I am worried that allowing the fishermen to choose the snow crab samples could provide a bias.

Page 5 - Annual trawl survey

I do not understand the fourth and fifth sentences which read:

"One or two locations were randomly chosen within each 10 minutes latitude by 10 minutes longitude grid. Once selected, the same stations were used every year while new ones were added randomly."

This indicates that the number of stations is continually increasing. I do not think that this is true, therefore, the statements should be reworded.

Page 10 - Tagging

The authors should reword this section by describing results of Eastern Nova Scotian tagging experiments and then indicate whether the Southern Gulf of St. Lawrence (SGSL) experiments support their results. At present, the section begins with the SGSL results and does not tie them into the Eastern Nova Scotian results.

Page 11 - Mobile gear Fisheries

The authors should clearly link this section to the assessment or remove it from the document.

Page 12 - Discussion

I am worried that the CPUE was artificially propped up by the blockades at the beginning of the season. The authors should take this into account when producing the CPUE estimates. At present the anomalies are treated as true estimates. The blockade periods are examples of anomalies and should be removed from the estimates.

COMMENTS AND QUESTIONS AND ANSWERS: GENERAL DISCUSSION

4X

John Tremblay
Q: Why are there so few females compared to males in ENS, while the opposite is true in Area 4X?
A: This is the area where we find females (Area 24E)

Q: Are there males in the untrawlable area in Area 4X?
A: Yes, I am open to that idea, but there is still very little crab in Area 4X.

Peter Koeller
Comment: Consideration should be given to a reduction of the quota. TAC is higher than what it should be. This is due to the over capacity (doubling of fishing licenses), low catch rate, and few signs of recruitment. I would add the very low CPUE in the season 2002-2003. It would be good to see more details on the Northern and

Southern populations with the temperature and how it might affect the biology and sustainability.
Reply: Roseway Basin area, always stay constant but very low.

David Orr
Q: Is there a way of teasing out different traps and do a model considering environment and fishing industry?
A: I did the history of the fishing in 4X. They fish in 2 places. The types of fishing traps they use, 2 different, cause a problem. We presented last year the CPUE between the 2 types of traps. The problem is when you have a mix of the 2 traps. It's hard to establish a CPUE.

Eastern Nova Scotia Areas 20-24

John Tremblay
Q: There is no analysis of the CPUE data. The CPUE data is not consistent with the trawl survey results.
A: (Michel Biron) CPUE is not a good predictor for future stock abundance. Before the crash in the southern Gulf of St. Lawrence, the CPUE was high. CPUE does not show warning signs of stock declines. The CPUE can remain high because fishermen move around to the good fishing spots. CPUE also does not account for varying soak times.
(Mikio Moriyasu) Catch rates did not change much before the SGSL crash, therefore the management strategies were not changed, but fishermen caught half as much as they did during the previous fishing season. The fishery crashed and this could not have been predicted based on CPUE data. Up to 1997, there was no sign of an increase in biomass based on CPUE and fishery data, but the trawl survey showed a greater biomass. Factors such as double hauling, number of trap hauls, and changes in trap types and fishing practices change CPUE. Standardization is a problem.

Q: Why are females not talked about in the document?
A: Data on females in N-ENS is in the poster presented at RAP. The data on females in S-ENS is being re-calculated because of uncertainties in its reliability. The numbers of females are comparable to last year. Multiparous females with eggs were found. There were no senile found, and few primiparous.

Michel Comeau
Comment: You have to be careful when looking at CPUE. The stock could drop off and CPUE would never give you a warning sign. You must look for changes in the fishing activity. If fishermen have to change their fishing activities to achieve the same result, there may be a problem with the stock. The link can be made with logbook information.

Q: How does the change in survey time influence the total biomass?
A: We are trying to consider how the change effects the biomass estimates. Changing the timing of the survey allows us to count the crab better. In the spring the

crab are on the banks. In the fall there are no crab on the banks. We miss the soft crab in the spring because they are inshore, but we are able to capture them in the fall.

Q: Did biomass decrease?
A: The adult biomass did decrease.

Peter Koeller
Comment: Page 16 is hard to understand. You are expecting a decrease, but not yet. The view you have of the stock has changed, but your advice has remained the same. The TAC is being kept at record levels to maintain the stock.
Reply: Yes, the stock will decline. The question is how fast.

Comment: You only present the results on the current year. You do not discuss changes from previous years.
Reply: (Mikio Moriyasu) The paper does not talk about a bunch of things, including the sex ratio and the numbers of multiparous females.

Comment: It is not good to dismiss the numbers of females.
Reply: (Mikio Moriyasu) Yes, but more information is needed before we can discuss the female population.

David Orr
Comment: Referring to p. 13 where the at-sea observer program is discussed, you should be concerned with high-grading. The protocol is a concern. You have the observers sample only 40 crabs per trap. There may be a bias toward large crab. When picking the crab, one may sub-consciously pick the best crab. Maybe instead of sampling 40 crab, the observers could sample the whole pot, and perhaps sample pots close to shore.
Reply: We have tried to do this.

Comment: Also, it may be beneficial to calculate CPUE per grid and find those grids that are equal to 95%. Then compare how the CPUE shifts through the season.

Bruce Osbourne
Q: Are the pulses in ENS the same as in the SGSL?
A: (Mikio Moriyasu) No, they are different. The growth rate is different. Growth is slower in the SGSL. This may be because of the high density of crab. We need to do more research on this issue.

Q: What about the pulse of small crab? (in terms of recruitment)
A: (Mikio Moriyasu) The ability of the trawl to catch crabs in the size classes 40mm and smaller is uncertain. We cannot rely heavily on this data set to predict the future of the stock.

Herb Nash
Q: Explain how the stock can go down, but the catch rates can increase and it is easier to catch the crab.
A: (Mikio Moriyasu) Catch rate tells us about the fishery after the fact. What happens in the fishery is not a predictive tool. In the Gulf, the fishery was going well and then there was a sudden crash. We have to determine how much of the total biomass relies on new recruitment.

Q: The stock is going down, but the catches are good. From this perspective, can we analyze the data from the snow crab the same way as the ground fish?
A: No, we cannot use the catches from one year to predict the future of the stock. We have to be conservative. The stock is going to be down, but it will go down quickly. We are not observing old crab, so the exploitation rate is not too low and we suggest a conservative approach for the years to come.

Winfred Risser
Q: Is the mean size of sampled crab by observers increasing? (good sign for fishery?)
A: (Mikio Moriyasu) There are three indices that can predict the future of the stock: the mean size measured by observers at sea - if there is a decrease in the size, this means there are no
new crabs coming into the fishery
the estimated biomass should be composed of new recruits and leftovers from the previous year's fishery
- if the biomass is composed of only recruits, this is a bad
sign and poses a threat to the fishery
the accumulation of older crab (biomass underestimated)
- if this happens, there will be more leftovers versus new recruits leading to an increased number of aged crab in the commercial catches

Q: Is the female snow crab biology similar to the biology of female lobsters?
A: (Mikio Moriyasu) In the Atlantic Canadian snow crab industry, female snow crabs are not targeted. They differ in that they can carry sperm longer and it can be used to fertilize two consecutive clutches.

Paul Kehoe
Q: Did you change the survey to account for mortality and the illegal fishery?
A: We changed the timing of the survey because we are able to catch the crab better in the fall and increase our coverage of the different classes of crab. Because we are now doing the survey after the fishery we do not have to try to estimate how much will be lost to fishery related mortality.

Q: Is the Glace Bay Hole like Area 18? Is it a nursery?
A: No, there is a lot of movement.

Fred Kennedy
Comment: There is a decrease in the biomass, no recruitment, and a decrease in the mean size of commercial crab.
Reply: No, there was no decrease in the mean size of commercial crab. Except in Area 20.

Q: Is the exploitation rate too heavy? Should the exploitation rate increase this year or should they decrease it?
A: (Mikio Moriyasu) I do not recommend that the exploitation rate be increased.

Q: What would happen if there was an increase in effort? Could there be an increase in the quota? An increase in the number of fishermen?
A: (Mikio Moriyasu) An increase in the number of fishermen is fine as long as the quota remains the same.

Neil MacMullin
Q: Is the movement into the Glace Bay Hole part of the uncertainties?
A: Yes

Q: Where are the crab going to and coming from?
A: (Mikio Moriyasu) This is a very interesting question. We will have to do more research to determine the answer. (David Orr) You could increase the number of samples in the area rather than increase the number of surveys.

Philip Nash
Comment: I do not believe that your trawl is working properly. You are missing crabs in the grids. The trawl does not hit the bottom.
Reply: The trawl is consistent. It may miss crabs because they are in a different area (not on the surface being trawled).

Comment: In the Glace Bay Hole, the biomass has decreased, but the catch rate is at record levels.
Reply: (Mikio Moriyasu) The biomass may be underestimated, but the estimates are better than they have ever been. If the amount of money we have to conduct surveys increased, we could survey the Glace Bay Hole monthly. There is a high amount of activity in and out of the Glace Bay Hole.

David Rambeau
Q: What about temperature changes (in the Glace Bay Hole)?
A: The temperature has been similar in the Glace Bay Hole for three seasons. The difference has been seen in the Cape Smokey and Sainte Anne area.

Q: What about upwelling?
A: (Ken Drinkwater) There could be daily and weekly changes, which would be a source of variability.

Appendix 1. Letter of Invitation

Gulf Region
Oceans and Science Branch
P.O. Box 5030
Moncton, NB E1C 9B6

January 14, 2003

Distribution

Subject: Peer review of snow crab stocks

You are invited to participate at the assessment of snow crab stock on the Scotian Shelf which will be reviewed at Mic Mac Amateur Aquatic Club, 192 Prince Albert Road, Dartmouth, N.S., February 26 and 27, 2003 (please see attached agenda).

This meeting will provide results of snow crab stock assessment for the northern (Areas 20, 21 and 22) and southern (Areas 23 and 24) portions of eastern Nova Scotia.

The purpose of this meeting is to conduct a thorough peer review of the stock assessment. Your participation is required to ensure that the review is of the highest quality.

Scientists will provide a brief overview of their assessments that should include the main conclusions, the supporting evidence, any new methods, and major limitations. The presentation will be followed by comments from any of the scientific referees and then from the invited industry participants. We apologise that any observers will be unable to contribute to the meeting.

Finalised stock status reports will be prepared at the meeting and the minutes of this meeting will be published as proceedings.

Région du Golfe
Direction des océans et des sciences
C.P. 5030
Moncton (N.-B.) E1C 9B6

le 14 janvier 2003

Liste de diffusion

Objet : Examen par les pairs des stocks de crabe des neiges

Nous vous invitons à participer à l'examen des rapports d'évaluation de stock de crabe des neiges du plateau néo-écossais qui aura lieu au Mic Mac Amateur Aquatic Club, 192 chemin Prince Albert, Dartmouth, N.-É. le 26 et 27 février 2003 (voir l'ordre du jour ci-joint.)

Cette réunion a pour but de fournir les résultats de l'évaluation des stocks du crabe des neiges dans la région nord (zones 20, 21 et 22) et sud (zones 23 et 24) de l'est de la Nouvelle Écosse.

L'objet est de réaliser un examen exhaustif des évaluations de stock. Pour que l'examen soit de la plus haute qualité possible, votre participation est essentielle.

À la réunion, les scientifiques présenteront un résumé des résultats de leurs évaluations, qui devrait comprendre les principales conclusions, les preuves à l'appui, les nouvelles méthodes utilisées et les principales restrictions. Leur survol sera suivi d'observations des examinateurs scientifiques, puis des participants invités de l'industrie. Malheureusement, les personnes qui souhaitent participer à la réunion à titre d'observateurs n'auront pas le droit de parole.

La version complète des rapports sur l'état des stocks sera préparée à la réunion et le compte rendu de la réunion sera publié dans des procès verbaux.

We would greatly appreciate your contribution to this important exercise and look forward to seeing you in February.

Nous vous serions très reconnaissants si vous pouviez contribuer à cette activité importante. Au plaisir de vous voir en février.

René Lavoie

Division Manager, Invertebrates Fish Division
Maritime Region

Gestionnaire de Division, Division des Invertébrés
Région des Maritimes

cc: M. Sinclair
M. Chadwick
B. O'Boyle
V. Myra

Appendix 2. List of Invitees

Peer Review of Snow Crab Stocks
February 26 – 27, 2003
MicMac Amateur Aquatic Club, 192 Prince Albert Road, Dartmouth, N.S./
Examen par les pairs des stocks de crabe des neiges
Le 26 et 27 février 2003
Mic Mac Amateur Aquatic Club, 192 chemin Prince Albert, Dartmouth, N.-É.

Eastern Nova Scotia participants/
Participants de l'Est de la Nouvelle-Écosse

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Appendix 4. Agenda

Peer Review of Snow Crab Stocks /
Examen par les pairs des stocks de crabe des neiges
MicMac Amateur Aquatic Club, Dartmouth, N.S. / N.-É.
February 26 – 27 / le 26 et 27 février 2003
Proposed timetable / *Horaire proposé*

Eastern Nova Scotia / L'Est de la Nouvelle-Écosse

Wednesday February 26 / *Mercredi le 26 février*	**Time / *Horaire***	**Lead / *Responsable***
Introduction	08:30 – 09:00 hrs *de 8h30 à 9h00*	(R. Lavoie)
Environmental conditions / eastern Nova Scotia // *Conditions environnementales / L'Est de la Nouvelle-Écosse.*	09:00 – 09:45 hrs *de 9h00 à 9h45*	K. Drinkwater
Health Break / *Pause-santé*	09:45 – 10:00 hrs *de 9h45 à 10h00*	
Fecundity and Sex Ratio Study // Étude de fécondité sex ratio	10:00 – 10:30 hrs *de 10h00 à 10h30*	E. Wade
Epibionts // *Épibiontes*	10:30 – 11:00 hrs *de 10h30 à 11h00*	L. Savoie
Tagging // *Étiquetage*	11:00 – 11:30 hrs *de 11h00 à 11h30*	C. Sabean
Lunch / Déjeuner (Buffet served at hall)	11:30 – 12:30 hrs *de 11h30 à 12h30*	
Snow crab, Area 4X / Presentation and discussion // *Crabe des neiges, zone 4X / Présentation et discussion*	12:30 – 1:30 hrs *de 12h30 à 13h30*	M. Biron
Snow crab, Areas 20-24 / Presentation and discussion // *Crabe des neiges, zones 20 à 24 / Présentation et discussion*	1:30 – 3:30 hrs *de 13h30 à 15h30*	M. Biron
SSR / Area 4X *RÉS / zone 4X*	3:30 – 4:30 hrs *de 15h30 à 16h30*	(R. Lavoie)

Thursday, February 27 / Jeudi le 27 février	**Time / Horaire**	**Lead / Responsable**
SSR / Areas 20-24 *RÉS / zones 20 à 24*	09:00 – 11:30 hrs *de 9h00 à 11h30*	(R. Lavoie)
Conclusion.	11:30 – 12:00 hrs *de 11h30 à 12h00*	(R. Lavoie)

Appendix 5. Meeting Remit

Meeting Remit

- Assess the status of Eastern Nova Scotia Snow Crab stocks until as late as possible in 2002. The assessment should include:
  - An analysis of existing fishery and survey information.
- Provide advice for the 2003 fishery.
- Produce a Stock Status Report and supporting Research Document documenting the results of the assessment.

Demande de Renvoi à la Réunion

- Évaluer l'état du stock de Crabe des neiges de la Nouvelle-Ecosse jusqu'aussi loin que possible en 2002. Cette évaluation devrait comprendre :
  - une analyse des données existantes de la pêcherie et du relevé;
- Formuler des conseils sur la pêche de l'année 2003.
- Produire un Rapport sur l'état des stocks et le Document de recherche connexe documentant les résultats de l'évaluation.

Appendix 6. Documents Tabled

Biron, M., C. Sabean, L. Savoie, and M. Moriyasu. 2003. Assessment of the 2001/2002 snow crab (*Chionocetes opilio*) fishery off southeastern Nova Scotia (NAFO Division 4X). RAP Working Paper 2003/09.

Referees : Michel Comeau, John Tremblay, Peter Koeller, David Orr.

Biron, M., L. Savoie, C. Sabean, E. Wade, and M. Moriyasu,. 2002. Assessment of the 2002 snow crab (*Chionocetes opilio*) fishery off eastern Nova Scotia. (Areas 20 to 24) RAP Working Paper 2003/10.

Referees : Michel Comeau, John Tremblay, Peter Koeller, David Orr